3-1920

Feeding Dairy Cattle

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Keywords
Animal Husbandry; Dairy Husbandry

Disciplines
Agriculture | Dairy Science

March, 1920 Circular No. 64

FEEDING DAIRY CATTLE

AGRICULTURAL EXPERIMENT STATION
IOWA STATE COLLEGE OF AGRICULTURE
AND MECHANIC ARTS

Animal Husbandry Section
Dairy Husbandry

Ames, Iowa

FEEDING DAIRY CATTLE.

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The dairy cow is a more efficient producer of human food than any other domestic animal. For each 100 pounds of digestible nutrients consumed she returns in her milk more than six times as much edible solids as the beef steer or mutton sheep yields in its carcass. As agriculture becomes more intensive the farmer has to pay greater attention to economy of production, so it is becoming necessary for him not only to use the most economical type of animal but also to have it producing to the best of its ability.

To insure successful milk production two things are fundamentally necessary, a productive dairy cow and a liberal system of feeding. A good cow will produce well for a considerable time on poor feed, but this is done at the expense of her own body and so if proper feed is not supplied she must produce less milk than she is really able to do and finally dry off when the stores of nutrients in her body are depleted. Lack of suitable feed explains why many cows in the corn belt are not producing well. They are fed on corn stalks and timothy hay with perhaps a little ear or shelled corn; in spite of this they produce well for a few months after calving, but they soon dry up and are idle until after their next freshening.

For the successful feeding of dairy cows a knowledge is necessary not only of the nutrients required by the animals but also of the various classes and quantities of these nutrients in the feeds used.

CONSTITUENTS OF FEEDS

Feeding stuffs are not simple substances but are composed of many complex chemical compounds. The constituents of feeds which are useful in the feeding of animals are called nutrients, and the various classes of these, proteins, carbohydrates, fats, ash, and water, are defined below:

A **nutrient** is a compound, or group of compounds of similar composition, which aids in supporting animal life.

The **proteins** are complex organic compounds containing, among other elements, nitrogen. Other more simple nitrogenous substances, such as amids, are also present. These are sometimes grouped with the true protein and the whole called crude protein.

The **carbohydrates** are composed of carbon, hydrogen, and oxygen, the hydrogen and oxygen being present practically always in the proportions in which they occur in water. This group is subdivided into crude fiber and nitrogen-free-extract. The crude fiber consists of materials such as are found in the woody parts of plants, while the best known examples of nitrogen-free-extract substances are starch and sugar.

The **fats** contain carbon, hydrogen and oxygen, but the hydrogen and oxygen are not present in the same proportions as in water.

The **ash** is the mineral part of the feeds.

Water, which needs no definition, occurs in all feeds and is exceedingly important.

FUNCTIONS OF NUTRIENTS

All the food nutrients consumed by an animal are not utilized. In its passage thru the stomach and intestines the feed is acted on by many digestive juices, and part is absorbed from the alimentary tract and taken into the blood. It is this part of the ration, the digestible nutrients, that is of greatest importance. It is the digestible protein, digestible fat, and so on, that must be taken into account in making up a ration.

Each food nutrient has several functions to perform in the animal body. The proteins are used for building up and replacing muscular and other active tissue and are very essential for the welfare of the animal. When more protein than is necessary for tissue building is supplied it is used for the production of heat and energy. In pregnant animals protein is also needed for the growth of the fetus and after parturition a considerable amount of the nitrogenous constituents of the feed is used in the production of the milk proteins.

Digestible carbohydrates, including both digestible fiber and nitrogen-free-extract, are used largely for the production of heat and energy, but may be converted into fats and stored in the body as such. Large amounts of them are used up in the production of fat and sugar of milk. The fats are more concentrated heat and energy producers than any other of the food nutrients and are also used as materials to be stored up in the body. They help in the production of the fat and other milk solids.

A pound of digestible fat in a feed will produce as much heat or energy in the animal body as will 2¼ pounds of digestible carbohydrates. Consequently, the sum of the digestible carbohydrates and 2¼ times the digestible fat in a feed is called the digestible carbohydrate equivalent.

The proteins can not be replaced by either fats or carbohydrates for the building of body or milk protein. As their heat and energy producing value is only equal to that of the carbohydrates and their cost is usually greater, protein should not be fed in excess if the most economical results are sought. The tissue and milk requirements for protein should be supplied by the feed and a little extra, as this has a stimulative action, but the nutrients needed for heat and energy production should be supplied mainly as fats and carbohydrates.

Ash, though present in feeds in smaller proportions than any other food nutrient, is absolutely essential. Its main function is to build up bone in the animal, and also in the fetus of pregnant females, and to form the mineral portion of milk. It has other functions which tho vital are less evident.

The water supplied to a cow, either in the feed or as drinking water, is required in the tissues and as a means of carrying the other nutrients from one part of the body to another and to the fetus and mammary glands. Its importance in the production of milk is easily seen when it is known that 87 pct. of milk is water.

DEFINITIONS OF FEEDS

The following definitions of feeding stuffs, officially adopted by the Association of Feed Control Officials of the United States, will give an idea as to the source, method of preparation, and general character of some of the more common feeds:

GENERAL DEFINITIONS

Meal is the clean, sound, ground product of the entire grain, cereal, or seed which it purports to represent.

Chop is a ground or chopped feed composed of one or more different cereals or by-products thereof. If it bears a name descriptive of the kind of cereals it must be made exclusively of the entire grains of those cereals.

Screenings are the smaller, imperfect grains, weed seeds and other foreign material having feeding value, separated in cleaning the grain.

Alfalfa meal is the entire alfalfa hay ground and does not contain an admixture of ground alfalfa straw or other foreign materials.

BREWERS' AND DISTILLERS' PRODUCTS

Brewers' dried grains are the properly dried residue from cereals obtained in the manufacture of beer.

Distillers' dried grains are the dried residue from cereals obtained in the manufacture of alcohol and distilled liquors. The product shall bear the designation indicating the cereal predominating.

Malt sprouts are the sprouts of the barley grain. If the sprouts are derived from any other malted cereal, the source must be designated.

BUCKWHEAT PRODUCTS

Buckwheat shorts or buckwheat middlings are that portion of the buckwheat grain immediately inside of the hull after separation from the flour.

CORN PRODUCTS

Corn bran is the outer coating of the corn kernel.

Corn feed meal is the by-product obtained in the manufacture of cracked corn, with or without aspiration products added to the siftings, and is also

the by-product obtained in the manufacture of table meal from the whole grain by the non-degerminating process.

Corn germ meal is a product in the manufacture of starch, glucose and other corn products and is the germ layer from which a part of the corn oil has been extracted.

Grits are the hard, flinty portions of Indian corn, without hulls and germ.

Corn gluten meal is that part of commercial shelled corn that remains after the separation of the larger part of the starch, the germ and the bran, by the processes employed in the manufacture of corn starch and glucose. It may or may not contain corn solubles.

Corn gluten feed is that portion of commercial shelled corn that remains after the separation of the larger part of the starch and the germ by the processes employed in the manufacture of corn starch and glucose. It may or may not contain corn solubles.

Hominy feed, hominy meal, or hominy chop is the kiln-dried mixture of the mill run bran coating, the mill run germ, with or without a partial extraction of the oil and a part of the starchy portion of the white corn kernel obtained in the manufacture of hominy, hominy grits and corn meal by the degerminating process.

Yellow hominy feed, yellow hominy meal or yellow hominy chop is a kiln-dried mixture of the mill run bran coating, the mill run germ with or without a partial extraction of the oil and a part of the starchy portion of the yellow hominy grits and yellow corn meal by the degerminating process.

COTTONSEED PRODUCTS

Cottonseed meal is a product of the cottonseed only, composed principally of the kernel with such portion of the hull as is necessary in the manufacture of oil, provided that nothing shall be recognized as cottonseed meal, that does not conform to the foregoing definition and that does not contain at least 36 pct. of protein.

Choice cottonseed meal must be finely ground, not necessarily bolted, perfectly sound and sweet in odor, yellow, free from excess of lint, and must contain at least 41 pct. of protein.

Prime cottonseed meal must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, yellow, not brown or reddish, free from excess of lint, and must contain at least 38.6 pct. of protein.

Good cottonseed meal must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, and must contain at least 36 pct. of protein.

Cottonseed feed is a mixture of cottonseed meal and cottonseed hulls containing less than 36 pct. of protein.

Cold pressed cottonseed is the product resulting from subjecting the whole undecorticated cottonseed to the cold pressure process for the extraction of oil, and includes the entire cottonseed less the oil extracted.

Ground cold pressed cottonseed is the ground product resulting from subjecting the whole undecorticated cottonseed to the cold pressure process for the extraction of oil, and includes the entire ground cottonseed less the oil extracted.

LINSEED AND FLAX PRODUCTS

Ground flaxseed or flaxseed meal is the product obtained by grinding flaxseed which has been screened and cleaned of weed seeds and other foreign materials by the most improved commercial processes, provided that the final product shall not contain over 4 pct. of weed seeds and other foreign materials, and provided further that no portion of the stated 4 pct. of weed seeds and other foreign materials shall be deliberately added.

Linseed meal is the ground product obtained after extraction of part of the oil from ground flaxseed screened and cleaned of weed seeds and other foreign materials by the most improved commercial processes, provided that the final product shall not contain over 6 pct. of weed seeds and other

foreign materials and provided further that no portion of the stated 6 pct. of weed seeds and other foreign materials shall be deliberately added.

Oil meal is the ground product obtained after the extraction of part of the oil by crushing, cooking and hydraulic pressure, or by crushing, heating and the use of solvents from seeds which have been screened and cleaned of weed seeds and foreign materials by the most improved commercial processes. When used alone the term "oil meal" shall be understood to designate linseed meal as defined. When used to cover any other product the name of the seed from which it is obtained shall be prefixed to the words "oil meal."

Old process oil meal is the ground product obtained after extraction of part of the oil by crushing, cooking and hydraulic pressure from seeds screened and cleaned of weed seeds and other foreign materials by the most improved, commercial processes. When used alone the term "old process oil meal" shall be understood to designate linseed meal as defined, made by the old process. When used to cover any other product the name of the seed from which it is obtained shall be prefixed to "old process oil meal."

New process oil meal is the ground product obtained after extraction of part of the oil by crushing, heating and by the use of solvents from seeds screened and cleaned of weed seeds and other foreign materials by the most improved commercial processes. When used alone the term "new process oil meal" shall be understood to designate linseed meal as defined, made by the new process. When used to cover any other product the name of the seed from which it is obtained shall be prefixed to "new process oil meal."

OAT PRODUCTS

Oat groats are the kernels of the oat berry.

Oat hulls are the outer chaffy coverings of the oat grain.

Oat middlings are the floury portions of the oat groat obtained in the milling of rolled oats.

Oat shorts are the covering of the oat grain lying immediately inside the hull, being a fuzzy material carrying with it considerable portions of the fine floury part of the groat obtained in the milling of rolled oats.

Clipped oat by-product is the resultant by-product obtained in the manufacture of clipped oats. It may contain light, chaffy material broken from the ends of the hulls, empty hulls, light immature oats and dust. It must not contain an excessive amount of oat hulls.

WHEAT PRODUCTS

Wheat bran is the coarse outer coatings of the wheat berry obtained in the usual commercial milling process from wheat that has been cleaned and screened.

Shorts or standard middlings are the fine particles of the outer and inner bran separated from bran and white middlings.

Wheat white middlings or white middlings are that part of the offal of wheat intermediate between shorts or standard middlings and red dog.

Red dog is a low grade wheat flour containing the finer particles of bran.

PEANUT PRODUCTS

Peanut oil meal is the ground residue obtained after the extraction of part of the oil from peanut kernels.

Unhulled peanut oil feed is the ground residue obtained after extraction of part of the oil from whole peanuts, and the ingredients shall be designated as "peanut meal and hulls."

THE CHARACTERISTICS OF FEEDING STUFFS

Feeding stuffs are as a rule divided into "concentrates" and "roughages" The concentrates are materials, such as the grains and factory by-products which contain very little crude fiber and are highly digestible. The rough-

ages are bulky materials, like hay and silage, and are considerably more fibrous than the concentrates.

CONCENTRATES

The concentrates are grouped here according to their origin, so far as possible, but occasionally it will be necessary to class them on the basis of their characteristics rather than their origin.

CORN. Corn is capable of providing a very large proportion not only of the roughages but also of the concentrates used on the dairy farms of Iowa. This feed is valuable chiefly on account of its carbohydrates, for tho it contains about 10 pct. of protein, other sources of this material are usually cheaper. It is also deficient in ash, particularly lime and sometimes phosphates. In the corn belt, corn must form the basis of the economical grain ration as it is usually the cheapest source of carbohydrates or energy supplying material. But corn should not be fed as the sole concentrate, especially where the corn plant is also supplying the silage or other roughage used; it should be supplemented by other nitrogenous feeds. It will be found more profitable to feed corn to dairy cows as cracked corn or corn meal rather than as ear or shelled corn because the prepared forms are more completely utilized.

SOFT CORN. The best way of handling a crop of soft corn is to put it in the silo, but sometimes this is not possible, and the grain has to be fed. Pound for pound, soft corn has not as high feeding value as well matured corn but when figured on the dry matter basis there is little difference between them. There is no reason why soft corn can not be utilized economically by the dairy cow if it is fed carefully and with proper supplements. The main difficulty in its use is the problem of storage as its high moisture content is favorable to mold growth.

CORN AND COB MEAL. Bulk, one of the essentials in a dairy ration, is the characteristic that makes corn-and-cob meal a valuable feed. When corn is fed in a finely ground form it may form pasty masses in the alimentary tract of the cow and then it is not only incompletely utilized, but it may also cause digestive disturbances. The fine particles of cob in the corn-and cob meal possess little if any nutritive value, but they have a very beneficial effect. They add bulk to the feed and, by keeping the particles of corn apart allow of more complete digestion. Therefore, corn-and-cob meal, tho it contains a large amount of indigestible fiber, is nearly as valuable pound for pound in feeding dairy cattle as corn meal. This is especially true when the ration is deficient in other bulky constituents.

CORN BRAN. Corn bran is now seldom on the market as it is used in the preparation of other feeds, for example gluten feed. It contains more fiber and less protein than wheat bran.

GLUTEN MEAL. Gluten meal is exceedingly rich in crude protein, containing on the average about 35.5 pct. It is a very heavy feed and likely to cause digestive disturbances unless fed in limited quantities.

GLUTEN FEED. Gluten feed is fairly high in crude protein, containing on the average about 25 pct. The addition of corn bran gives it a much higher percentage of crude fiber than gluten meal but the increased bulk adds materially to its usefulness. Where the soluble materials of the steep water have been added the ash content is also good. As a rule gluten feed is a fairly economical source of protein, but being a corn by-product it should not be the only concentrate used to balance a ration containing a large amount of corn.

GERM OIL MEAL. This feed contains less protein than gluten feed, but on the average it contains almost 11 pct. of fat. It is unpalatable and tends to become rancid when stored and so it is not especially suited for dairy cattle feeding.

HOMINY FEED. Hominy feed differs very little in composition from corn, tho it contains greater amounts of fiber, fat, and ash. It is essentially a carbohydrate feed which can often be used economically, especially as it is bulkier than corn meal tho rather less digestible.

CORN DISTILLERS' GRAINS. Distillers' wet grains are too bulky to be profitably shipped far and as their watery nature makes them perishable they are usually dried. The distillers' dried grains contain about twice as much crude protein and three times as much fat as wheat bran, and have a feeding value above that of gluten feed. Being bulky and containing about 31 pct. of crude protein they form an excellent feed.

OATS. Oats vary considerably in quality. In the south they have a large percentage of hull and a light bushel weight, while in the north they are plumper and weigh more per bushel. Oats are higher in crude protein, fiber and ash than corn and almost equal to it in percentage of fat. There is no grain better than oats for milk producing cows or cows about to freshen, but they are frequently too high in price to be fed economically except in limited quantities to high producing cows. It is usually best to grind oats before feeding them to dairy cattle. Not only are they very palatable, but when ground and mixed with the rest of the grain ration they increase its bulk and thus enhance its value.

OAT BY-PRODUCTS. Several by-products, including oat hulls and oat shorts or middlings, are obtained in the manufacture of oatmeal but they are of little importance in feeding dairy cattle, except as constituents of mixed feeds. Oat hulls contain almost 30 pct. of crude fiber and have little feeding value. They are usually mixed with other feeds and their bulk may then have some beneficial effect. Oat middlings contain more fat than wheat bran. As with oat bran, oat dust and oat clippings, they are usually put into mixed feeds.

WHEAT. As wheat is the chief American grain for human consumption and consequently demands a high price, only poor or spoiled lots are available for stock feeding. Wheat contains more protein, ash and carbohydrates than corn but it is lower in fat. Tho higher than corn in protein it is a carbohydrate feed. Damaged wheat as a rule differs little in composition from good grain but occasionally contains more protein. It is about equal to corn for milk production and when used should be ground.

WHEAT BRAN. The protein content of wheat bran is high, running usually about 16 pct. of crude protein. It has a fair amount of other digestible nutrients, tho it has a relatively high content of crude fiber. The ash content is also high and is rich in phosphates, tho poor in lime. Bran is light and bulky, is extremely palatable and has a beneficial and cooling effect on cows. Owing to its high price it is sometimes not a very economical protein supplement for corn and other carbonaceous feeds. It can seldom be profitably fed to all the animals in a herd, but even tho it is high priced it is usually advisable to feed it to cows just before and after freshening, to animals that are being forced for records and to young stock. Its laxative properties and its palatability render it extremely useful, in the form of mashes, for cows that have gone off feed.

WHEAT MIDDLINGS. Standard wheat middlings or shorts, tho higher in protein than wheat bran, should seldom be fed to dairy cows. They are not palatable and there are other more economical sources of protein. When fed middlings should be used in small quantities only and mixed with other feed.

FLOUR WHEAT MIDDLINGS. This feed contains less crude fiber and more protein than the standard wheat middlings. Like shorts they should be fed in limited quantities, if at all.

RED DOG FLOUR. This contains less fiber and ash and more nitrogen-free-extract than wheat bran. In feeding value it is very similar to good flour middlings.

BARLEY. Barley is a common feed where corn can not be grown successfully and is excellent in value. It is rather higher in crude protein and fiber, and lower in fat, than corn and its nutritive value is just a little less. When fed it should be rolled instead of being ground, as barley meal is likely to cause indigestion. Being carbonaceous, it requires to be supplemented with protein feeds. It is palatable and when it can be obtained at a reasonable price makes valuable addition to the ration of the dairy cow.

BARLEY SHORTS AND BARLEY BRAN. These products contain less protein than the corresponding wheat products and are not important in dairy cattle feeding. They are being used to some extent, however, in the northern sections but should not be used as the sole protein supplement in the ration of a milking herd. Where they are used it should be in limited amounts and in conjunction with such a supplement as oil meal.

MALT SPROUTS. The dried sprouts from the malted barley grains contain about 26 pct. of crude protein. This is fairly easily digested but a large part of it is not true protein. Malt sprouts contain over 12 pct. of crude fiber and the percentage of nitrogen-free-extract and fat is low. They are bulky, but owing to their unpalatable nature not more than two or three pounds per head per day should be fed and they should be soaked in water for several hours before feeding as they are dusty and absorb large quantities of water and might cause digestive disturbances if fed dry.

BREWERS' WET GRAINS. Owing to their bulk and to the fact that they should be fed fresh, brewers' grains are in common use only near breweries. When properly handled they make a profitable feed for dairy cows, the usual allowance being 20 to 30 lbs. per day. It is very essential that they be fed before decomposition starts, otherwise digestive disturbances are sure to result and the odors from the decomposing feed will also be imparted to the milk.

BREWERS' DRIED GRAINS. They form a bulky feed and contain about 10 pct. more crude protein than wheat bran. They have a higher percentage of fiber and fat and a lower percentage of ash than bran. Brewers' dried grains can often be used as a protein supplement and usually are more economical than wheat bran. They add bulk to the ration but they have not the same beneficial laxative and cooling effect on the system as bran.

RYE. Rye is not quite such an efficient feed for milk production as corn. In composition it differs little from wheat, containing slightly less protein, fiber and fat and a little more ash and nitrogen-free-extract. It is not very palatable to dairy cows and large quantities of it tend to cause digestive disturbances and perhaps taint the milk. Two or three pounds per day may be safely fed along with other concentrates.

RYE BY-PRODUCTS. The chief rye by-products are middlings, bran and distillers' grains. The rye middlings and bran do not differ much from the corresponding wheat by-products except that they are somewhat lower in fiber, fat and protein, and are unpalatable. When they are used they should be given in limited amounts and mixed with other concentrates as in this way they do not tend to lower the palatability of the ration so markedly. Rye bran and middlings are frequently mixed and sold as rye feed. Rye distillers' grains are considerably lower in protein and fat than those made from corn and are consequently of less value in the feeding of dairy cattle.

BUCKWHEAT AND ITS BY-PRODUCTS. Buckwheat and its by-products are not much used in the feeding of dairy cattle. Buckwheat middlings containing over 28 pct. of crude protein, make quite a good protein feed but are often mixed with the hulls and sold as buckwheat bran or feed.

EMMER. This feed, also known as spelt, is not common in Iowa and is not as valuable as corn for dairy cows. It contains about 12 pct. of crude protein.

KAFIR. This feed, containing about 11 pct. of protein, is of little importance in Iowa. As it is constipating it should be fed along with laxative feeds.

MILO. Milo is very similar to kafir in composition but it has a laxative rather than a constipating effect.

RICE AND ITS BY-PRODUCTS. Damaged rice, both rough and hulled is sometimes fed to cattle but the quantity available is small. Rice hulls should never be fed to cattle, for not only are they very fibrous and practically lacking in digestible nutrients, but they contain a large percentage of sandy material which causes great irritation in the digestive tract and may even result in death. Rice bran, when of high grade, contains about 12 pct. crude protein and 11 pct. fat but it is not considered a good feed for

milk cows as it is likely to become rancid and is said to spoil the flavor of the milk even when fed fresh. Rice polish is little used in feeding.

FLAXSEED. This is used in the feeding of calves but not of cows as it is too expensive.

LINSEED OIL MEAL. New process oil meal contains less fat than the old process. Owing to differences in values, new process oil meal is sometimes substituted for old process, but the following simple test will enable anyone to distinguish between them. Put a little of the finely pulverized meal in a glass and to it add ten times its volume of boiling water. Stir thoroly and allow to stand undisturbed for an hour. If the meal settles to the bottom and leaves the water clear, it is new process; if the mixture remains jellylike, it is old process. Linseed oil meal is one of the best feeds for dairy cows. It contains a large amount of digestible nutrients and has a laxative and cooling effect upon the system. It is a very safe feed, and tho its high price frequently makes it a less profitable source of protein than some other high protein feeds, it is often advisable to use it for animals that are off feed, in low condition, or being prepared for freshening or Advanced Registry tests. The old process meal contains 3 pct. less crude protein and 4½ pct. more fat than the new process; it is also more digestible and has a better effect on the system, and so should be fed instead of the new process if the difference in price is not too great.

COTTONSEED. Very little whole cottonseed is now fed to cattle as nearly all of it is used in the manufacture of oil.

COTTONSEED HULLS. These are extremely high in fiber and very low in digestible nutrients. They should not be bought for a dairy feed, tho they are sometimes used as a filler in cottonseed feeds.

COTTONSEED MEAL. This is one of the richest and most nitrogenous feeds available and is often an economical source of protein. Cottonseed meal is sold according to the following grades: choice, prime, and good. Besides being rich in protein, cottonseed meal contains a relatively large amount of fat and ash which also add to its value. It has a constipating effect and so should be fed with such laxative feeds as linseed oil meal and bran. Cottonseed meal should always be bought subject to guarantee as it varies greatly in protein content. It should be in good fresh condition as mouldy meal is not only unpalatable but also dangerous to stock. Under certain conditions any grade of cottonseed meal may prove poisonous and it should never be fed to young calves or to cows about to freshen. However, there is no danger in feeding a limited amount, two or three pounds a day to milking cows, provided it is mixed with laxative, bulky and less nitrogenous feeds. It is an excellent feed for cows on pasture, as its constipating action counteracts the effect of washy grass. Unlike oil meal, it serves to harden butter which oftentimes tends to be soft during the summer. The adulteration of cottonseed meal with hulls can be detected by the following simple test. A teaspoonful of the meal is stirred up with about two ounces of boiling water until all the particles are wet and floating. The mixture is allowed to settle for five or ten seconds and the water poured off. The presence of a dark brown sediment in large amounts indicates adulteration.

COTTONSEED FEED. A large percentage of hulls is characteristic of this meal and it cannot be advocated as a feed for dairy cows.

COLD-PRESSED COTTONSEED CAKE. This feed contains more fiber than cottonseed meal, due to a larger percentage of hulls, and it is consequently less valuable as a feed. It is usually sold as broken cake but sometimes it is ground into a meal. It is also put on the market under various trade names.

CANADIAN FIELD PEAS. Field peas contain about 23 pct. of crude protein and make an excellent supplement to corn.

COWPEAS. These are very similar in composition to field peas. There is not a large acreage of this crop in the corn belt and the bulk of it is used for silage and hay.

SOYBEANS. Of the leguminous seeds used in cattle feeding, this is the richest in crude protein and ash. The residue left after the extraction of the

oil from the beans is sold as soybean cake or meal and used for feeding. The extracted soybean meal has about 41 pct. of crude protein and 7 pct fat, or in other words 5 pct. more protein and 10 pct. less fat than there is in the soybeans. Both are excellent feeds for dairy cows, tho they tend to produce a soft butter. An abundance of carbohydrate feeds should be fed with them.

PEANUT BY-PRODUCTS. The use of peanut meal as a feed for dairy cattle is increasing and promises to become important. The meal from hulled peanuts contains over 40 pct. of digestible crude protein and differs little in value from choice cottonseed meal tho it is perhaps less palatable. The meal from unhulled peanuts, or peanut feed, contains about 23 pct. of crude fiber and 20 pct. of digestible crude protein and consequently is of much less value. The peanut by-products tend to produce a soft butter. Peanut hulls are sometimes ground and used for adulterating feeding stuffs or fraudulently sold as "peanut bran." They contain over 50 pct. of crude fiber and are less valuable than straw for feeding purposes.

COCOANUT-MEAL. This by-product, obtained in the abstraction of oil from the cocoanut, is now found on the market to a limited extent. It contains about 18 pct. of digestible crude protein while its fat content varies widely. It has given good results in some cases and is fairly palatable when fresh tho it tends to become rancid if stored for long periods.

MOLASSES. Molasses whether from sugar cane or sugar beets, is a valuable carbonaceous feed. The two varieties do not differ much in composition tho the beet molasses is likely to have a purgative action due to the alkaline salts present. The protein in molasses has little nutritive value. Owing to its high price molasses is often not an economical feed but sometimes it is valuable as an addition to feeds of poor quality, such as badly weathered hay or musty grain. The molasses, either alone or diluted with water, is poured over the other feeds. Not more than two or three pounds per cow per day should be fed. Animals well along in pregnancy should receive molasses only in limited amounts, if at all.

PROPRIETARY FEEDS

The man in charge of livestock is frequently tempted to avoid the labor of choosing and mixing the concentrates. Consequently, many proprietary feeds are on the market and a number of these have nothing to recommend them but their name and appetizing odor. The protein content of such feeds is usually fairly high, but the price asked for them is frequently exorbitant.

All proprietary feeds should be bought on the basis of their content of digestible nutrients and not on the claims made for them. Where possible a statement of the constituents from which the mixture is made should be obtained as frequently this is a good indication of the value of a feed. The proprietary feeds found on the market vary very widely in nature and value and can best be considered when grouped according to the nature of their components.

STANDARD FEEDS. These consist of well known concentrates sold under trade names. Generally only one constituent is present. They are usually valuable feeds and sold at reasonable prices tho occasionally the prices asked are too high .

MIXED CONCENTRATES. A large number of firms manufacture feeds that are mixtures of common concentrates and practically any of the well known grains and factory by-products can be found in such mixtures. They are usually good feeds and can be bought safely when the price paid for them is in proportion to their content of digestible nutrients.

ALFALFA MOLASSES FEEDS. There are on the market a very large number of feeds, the basis of which is ground alfalfa hay or alfalfa meal. They usually contain some molasses and practically any of the common concentrates as well as a large number of useless materials and adulterants are to be found in combination with the basal materials.

Such feeds, when made from good alfalfa hay and concentrates of high quality, are legitimate and their sale can not be criticized so long as they are priced in accordance with the amount of digestible nutrients they con-

tain. However, some of these alfalfa-molasses preparations are made from poor quality alfalfa hay or even alfalfa straw flavored with molasses and contain negligible amounts of valuable concentrates. Damaged grains, mill refuse, and other materials of doubtful feeding value are also used in their make-up. Such feeds should not be used.

PEAT-MOLASSES FEEDS. The peat-molasses feeds may fill a demand from men who wish to use molasses in a form that is easy to handle. Their sale for this purpose may perhaps be justified so long as they are represented to be what they actually are—molasses absorbed by peat—and no fake claims are made regarding the feeding value of the peat. In some cases, however, very exorbitant claims have been made for such mixtures, and a direct feeding value has even been attributed to the peat.

Peat has no direct feeding value and the large amount of fiber which it contains sometimes decreases the digestibility of the other constituents of the ration with which it is fed. Again, some peats used in the manufacture of proprietary feeds contain large amounts of sand which has an irritating effect on the alimentary tract of any animal consuming it and this may lead to serious digestive disturbances.

FILLERS. A considerable number of mixtures of little or no feeding value are on the market. They are usually composed of waste materials which can not be disposed of in any other way, with the addition sometimes of constituents which will increase their apparent content of protein and substances which impart to them a pleasing aroma.

Some of the materials frequently used in the compounding of such preparations are mill sweepings, low grade or damaged grains, cottonseed hulls, oat hulls, rice hulls, flax straw refuse, ground peat, and ground leather. The majority of these materials are absolutely devoid of feeding value and in some cases they contain so much sand and grit as to be dangerous when fed to livestock. It is obvious that feeds of this type should not be bought at any price.

STOCK TONICS. The so-called conditioners, tonics or stock feeds are not needed. The majority of them are harmless. They frequently consist of inert materials or small amounts of good feeds to which have been added such cheap ingredients as common salt, sulphur, charcoal, alum, copperas, Epsom salts, and Glauber's salts, with occasionally such aromatic substances as fennel, anise seed, fenugreek, and ginger. The aromatic constituents are supposed to render them appetizing.

When the low cost of the ingredients is considered the price asked for the majority of stock tonics is unreasonably high. If they fulfilled the claims made regarding their curative properties such prices might be justified.

However, they do not fulfill such claims. Some of the feeds called "tonics" do have medicinal properties but it is preposterous to claim that one highly odoriferous powder will cure all animals ills, especially in the light of the fact that specific ills require specific treatment and even individual animals have their special requirements in health as well as in sickness.

Stock tonics should not be purchased at any price for the simple reason that a cow in good health needs no tonic and a cow that is off feed or otherwise out of order can be treated by cheaper and more effective methods.

ROUGHAGE

The roughages used in the feeding of dairy cattle should as a rule be home-grown. There is no more economical way of marketing the hays and other roughages grown on the farm than by way of the dairy cow, provided they are suitable for dairy cattle. The roughages can be classed as succulent, including pasture, roots, silage and soiling crops, and dry forages, such as hay, fodder, and stover.

SUCCULENT ROUGHAGES

No feeds will induce greater or more economical milk production than succulent ones and it is essential that a supply of these be on hand thruout

the year. With a judicious combination of pasture, soiling crops and silage this can be obtained.

PASTURE

Good succulent pasture is the feed, par excellence, for the dairy cow. It is not only bulky and succulent, but it contains the necessary food nutrients in about the correct proportions. The pasturing season in Iowa usually lasts from May to October. For the first six weeks or two months no additional rough feed will be required and during the early part of the season, it is well to cut down, and in most cases to eliminate entirely, the grain ration of all except the heaviest producers. This cools and rests the digestive tract and the cow is in much better shape to handle concentrates when it again becomes necessary to feed them. From the time pasture begins to dry up, as a rule about the middle or end of June, until the end of the pasturing season, it is well to feed soiling crops or silage and some concentrates. By the use of soiling or silage not only will the milk production per cow be increased, but the carrying capacity of the farm can also be considerably augmented. Bluegrass makes an excellent pasture while it lasts, but its period of usefulness is usually short. For a good cow pasture nothing equals a mixture of grasses and clovers, as the variety improves the palatability, the clovers increase the protein content, and the clovers and mixed grasses supply excellent feed after the bluegrass season is past.

If pasture is used without soiling or summer silage it will require one and one-half to two and one-half acres per cow to get the best results, whereas if silage or soiling is fed the pasturage allowance can be economically cut down to as low as one-half acre per cow. The carrying capacity and returns from a pasture are greatly influenced by the method in which it is handled. It should be well drained and regularly manured. The stock should not be turned onto it in spring until the land is fully dry and growth is well started. Stocking the pasture before there is a good cover lessens the vitality of the forage, and trampling on wet ground does much damage. Overstocking at any time is also inadvisable. Weeds detract from the value of a pasture and should be kept down at all times.

SILAGE

Corn silage is essential on all dairy farms in the corn belt. Without it the largest and most economical milk production cannot be obtained. Corn being a succulent plant which is easily harvested and put thru the cutter makes an excellent silage crop.

That the use of the silo makes possible the most efficient harvesting of the corn crop is shown by the following figures from the Wisconsin Agricultural Experiment Station. During four years' work there it was found that when the corn crop was dried in the shock there was an average loss of 23.8 pct. of the dry matter and 24.3 pct. of the crude protein, whereas when the corn was made into ensilage the respective losses were 15.6 pct. and 16.8 pct. This shows a considerable conservation of the valuable food nutrients. Then again, when the crop has been put into the silo all of it will be consumed by the animals, whereas when the corn has been shocked the stock will refuse a large portion of it.

The stage of ripeness at which the crop is cut has a great influence on the yield and quality of silage produced. If the ensiling is done too early the largest yield of nutrients will not be obtained. Also, owing to the large percentage of water and soluble substances present, the fermentation will be excessive, much valuable feeding material will be lost, a poor quality of silage will result, and the silo may leak. If the cutting is delayed too long, the yield of dry matter will be largest, but owing to the large amount of air present, due to the difficulty of tramping the dry material, the contents of the silo may become moldy and perhaps rot unless water is added at the time of filling. Moldy silage is not only undesirable but is sometimes dangerous to the stock.

The best silage is produced when the corn is cut just as the kernels are well dented. At this stage the yield of dry matter is large and there is

still usually sufficient moisture to insure thoro packing and a succulent, palatable silage.

The figures in Table I adapted from "The Soft Corn Predicament" by Evvard of the Iowa Agricultural Experiment Station, illustrate well the facts mentioned above.

TABLE I. COMPARATIVE YIELD OF FOOD NUTRIENTS IN AN ACRE OF CORN AT DIFFERENT STAGES OF GROWTH. MATURE YIELD TAKEN AS 100

Stage of Growth	Dry Matter	Crude Protein	Nitrogen Free Extract	Crude Fiber
In the milk	66	79	61	78
In the glaze	86	82	86	88
Well Dented	95	95	96	92
Ready to shock	100	100	100	100

Tho good succulent corn is best for silage, fairly satisfactory silage can be made from a corn crop damaged by drought or frost which otherwise would be largely wasted. Such material is not necessarily poor or dangerous as a feed. It contains the same amount of nutrients as it did immediately before it was damaged, tho of course less than if it had been allowed to come to the proper stage of development. If it is ensiled as soon as possible after it is damaged it will come out of the silo in the spring in good condition. If allowed to dry out, however, add water as the corn is being put into the silo to assist in its packing, and to impart the necessary succulence. Corn fodder that has been dried in the shock can also be made into good silage if plenty of water is added. Tho not just as palatable as the silage made from the fresh green forage, it gives good results and will be more thoroly utilized than would the dry fodder. Similarly, corn stover can be made more valuable as a feed by being put in the silo, tho of course the absence of the ears lowers its feeding value.

The value of corn silage is due largely to its succulence, bulk and palatability, and to its beneficial effect upon the digestive tract of the animal. In effect it is laxative and cooling. These are the essential characteristics of a good ration for a dairy cow and they make silage an excellent feed for milk production. The feeding of silage in winter gives many of the advantages of pasture as the essential characteristics of the two are very similar.

Silage, tho of greater value in winter, can be used to considerable advantage in summer when the pasture is short and dry. The feeding of silage in the barn during the hot dry weather of July and August not only supplements the rather scant pasture, but also allows the cows to feed in a cool place where they can be sprayed to keep off the flies.

Tho feeding silage is not a difficult matter, it should be done with care or trouble may arise. The silo should be of such a diameter that enough feed will be taken out each day to prevent decomposition of the top layer. This is especially important in the summer, so if a silo is erected for summer use only it should be of smaller diameter than the winter silo. In winter the silage will keep well if at least two inches per day are removed for feeding purposes, but in summer about four inches per day should be fed from the silo.

Table II shows the number of cows that can be kept during the winter with various sized silos, and has been calculated from results obtained by the Nebraska Station. The length of the silage feeding period is taken as 225 days and the average amount of silage fed as 30 lbs. per day, or a total of about three and one-third tons of silage for each cow during the winter. The heights given are the heights of the silos from the bottom of the pit to the eaves. The depth of the silage will be about six feet less than this, depending upon the amount of settling. Where young stock have to be fed an additional allowance must be made for them. With large herds it will usually be found best to build two silos of small diameter, rather than one of large diameter as it is well to have the total depth of the silage in the silos not less than 36 to 38 feet. If it is less than this and has to

be fed all winter the amount removed each day for feeding purposes will be a layer less than two inches thick and the risk of the silage spoiling will be greater. For this reason data is given in the table on several silos of small diameter.

TABLE II. SILAGE REQUIRED FOR HERDS OF 10 TO 100 COWS

Diameter of Silo—Feet	10		12		14		16		18	
Height of Silo—Feet	Cap'y Tons	No. of Cows	Cap'y Tons	No. of Cows	Cap'y Tons	No. of Cows	Cap'y Tons	No. of Cows	Cap'y Tons	No. of Cows
30	41	12	59	17						
32	45	13	64	19						
34	49	14	70	21						
36	53	15	76	22	103	30				
38			82	24	111	33				
40			88	26	120	36				
42			94	28	128	38	167	50		
44					137	41	179	53		
46					146	43	190	57		
48					154	46	202	60	256	76
50					164	49	214	64	271	81
52							225	67	286	85
54							239	71	302	90
56							250	75	317	95
58									333	99
60									350	105

At one time it was considered that good milk could not be produced when silage was fed, but this has been found to be incorrect. Milk will rapidly take on a silage odor when exposed to it, but in a well managed barn it should not have this opportunity. If the silos are shut off from the barn, the silage fed after milking, the amount limited to what will be cleaned up in a short time, and the milk removed from the barn as soon as it is drawn, there is no danger of having a noticeable silage odor in milk. Bad odors of any kind in milk are as a rule due to carelessness.

Even at the present time it is sometimes said that silage causes the teeth of cows to decay, brings about digestive troubles and may even induce abortion. These statements are incorrect. Silage does not cause teeth to decay and unless it is badly molded or decayed or suddenly fed in too large amounts it will not cause digestive troubles or abortion.

SOILING CROPS

Soiling crops are also excellent for supplementing pasture in summer. With the aid of soiling crops the area of pasture needed for the dairy herd can be reduced, or more animals can be kept, and consequently the cost of milk production lowered. The other advantages are similar to those obtained from the feeding of silage during summer, with the addition of variety. Several crops can be used successfully in Iowa for soiling, the most important ones being alfalfa, amber cane, and a mixture of oats and Canadian field peas.

The various cuttings of alfalfa can be utilized successfully for soiling, tho the time they can be used is limited. If the cutting is started too early it will decrease the yield and if it is delayed too long the following crop will suffer. The daily amount of green alfalfa consumed by cows is not as great as for some other feeds.

Oats and Canadian field peas are among the most valuable early soilings. When the oats are in the milk and the peas have filled the pods, but have not commenced to dry, they form a very palatable and highly nutritious succulence. The main drawback to this mixture is that it ripens rapidly and when ripe is not so palatable. Owing to their early and rapid growth, however, they are well suited for the early part of the dry season.

Amber cane gives larger and cheaper yields of green feed than any other soiling crop in this section. It should be sown thickly as then the crop is

much finer stemmed and more palatable and there is very little waste in its consumption. Amber cane is the most valuable soiling crop for the late part of the season and is available during a long period.

Millet proves a fairly good soilage for use late in the season and can be used up until the time of frost. Green corn is also used for this purpose. It is difficult to handle but green sweet corn stover is a soiling that generally proves economical in the vicinity of canning factories.

Those are but a few of the crops that can be used for soiling purposes, and more detailed information regarding the use of soilage is given in Bul. 187 of the Iowa Agricultural Experiment Station.

Soiling is not generally as cheap as summer silage yet it makes possible a decrease in the cost of summer milk production. During the last seven years 40 cows have been maintained at the Iowa State College dairy farm on an average of 20 acres of pasture and 12 acres of soiling crops. The average consumption of soiling was 1.93 tons per cow for the season at a cost of $5.30. This with $3.30 for pasture made a feed cost, exclusive of grain of $8.60 per cow per season. If pasture alone had been used to provide succulence for the cows the cost would have been $12 to $18 per cow and in addition more grain would have been necessary and the milk production undoubtedly would have decreased. The economy of soiling, where silage is not available, is evident.

The choice between summer silage and soiling crops depends largely on individual conditions. On the average farm, if a silo of small diameter is available, summer silage is probably the more economical, especially if help is scarce. Where no silo is available soiling crops should be used, and on large dairy farms, more cows can usually be kept by growing soiling crops than by feeding summer silage. For the most efficient and economical milk production one or the other is essential.

ROOTS

Root crops are not much in evidence in Iowa and are not very important in any part of the corn belt. Pound for pound of dry matter roots have about the same feeding value as corn silage and so owing to the small yields and the high cost of production it seldom pays to grow any large quantity of them. However, where cows are being run on official test and large records are wanted, it is often advisable to have a few roots, as their palatability and succulence will increase the flow of milk. Sugar beets, mangels, and rutabagas are most commonly used. Potatoes might also be put in this class as cows will utilize small potatoes efficiently. Potatoes have to be fed carefully, however, owing to the danger of choking and to the fact that too large quantities of them will produce milk and butter of poor flavor.

BEET PULP

This is the residue from the manufacture of beet sugar. Wet beet pulp makes an excellent succulence for supplementing or even replacing silage. Owing to its high moisture content it cannot be used economically except close to the sugar factories where the cost of transportation is small. It is usually bought in the dried condition and soaked before feeding. It should be soaked for about twelve hours and will take up about three times its weight of water. It can be fed with the silage, or as a substitute if silage is not available. When fed as the sole succulence from four to eight pounds per day of the dried material can be given and when fed with silage two to four pounds will be as a rule sufficient.

DRIED ROUGHAGES

The dairy cow is preeminently a consumer of roughages and usually provides the most economical market for those grown on the farm. They supply the bulky and fibrous part of the ration so necessary for the most efficient action of the cow's digestive system.

CORN FODDER AND STOVER. Corn fodder and stover, tho not so good as silage, make fairly good carbonaceous roughages. Where they have to be fed, some nitrogenous hay should be used. Where there is silage and

also some fodder or stover available, it is often advantageous to give the cows a little of the fodder or stover in addition to their silage. They will relish small quantities of it, and a good plan is to give the cows access to it when out for exercise.

STRAW. The cereal straws, being poor in protein, low in digestibility, and unpalatable, are not good roughages for milk cows.

TIMOTHY HAY. This roughage is too fibrous and poor in protein to make a good cow feed. Its feeding value is about the same as that of oat straw and it should not be fed to milking cows. Usually it can be sold for as high a price as it takes to buy alfalfa hay and in this case the best policy is to sell the timothy and buy alfalfa.

SUDAN GRASS HAY. This hay provides energy more efficiently than does timothy hay and is more palatable tho it is not a good source of protein. It is not satisfactory for milk cows but can be used in the feeding of dry stock.

MIXED HAY. Hay from mixed grasses is better than timothy and if there are some legumes present it makes a fairly satisfactory feed.

OAT AND PEA HAY. A mixture of oats and Canadian field peas, in equal parts and drilled in at the rate of three bushels per acre, will yield a good hay for dairy cows. The best results are obtained when the crop is cut just as the oats are entering the dough stage. Tho not quite so good as alfalfa or clover hay it makes an excellent substitute.

ALFALFA HAY. This is undoubtedly the best dry roughage for dairy cows. It has a high content of valuable nutrients, especially protein and ash, a good effect upon the system and it is palatable. These properties, in addition to its bulk, render it an excellent material for balancing the silage and corn part of the ration. For best results alfalfa hay should be harvested in good condition. One of the main points to remember in curing alfalfa is that the leaf waste should be kept as low as possible. The leaves are the most nutritious part of the plant and every care should be taken to cure the hay with a minimum of handling, as each time the hay is handled some of the leaves are lost. One of the main functions of alfalfa hay in the ration is to supply protein and tho it can not be used to eliminate the grain ration, the concentrates fed can be rather less nitrogenous when it is used. Similarly, alfalfa meal is a roughage and not a concentrate, consequently it should not be fed as a substitute for the grain ration. If good alfalfa hay is obtainable alfalfa meal should not be used.

CLOVER HAY. The value of clover hay for milk production is about four-fifths that of alfalfa hay. Except that it contains rather less protein than alfalfa it is very similar and the statements regarding alfalfa apply also to clover hay.

SWEET CLOVER HAY. Not much has been done with sweet clover so far but it is probably about equal in value to alfalfa hay for feeding purposes. Stock usually object to it at the start when it is in the fresh green state. This is probably due to the presence of the bitter principle, cumarin. In the curing of the hay this objectionable substance is perhaps destroyed to some extent and the hay is consequently more palatable than is the green feed.

REQUIREMENTS OF A DAIRY RATION

The main object in feeding cows is to get the largest and most economical milk production. To do this it is necessary to know how to compound a ration. This is not a very difficult proposition when the composition, properties and prices of the various feeds available are known. In compounding a ration the following points must be considered: palatability, variety, bulk, succulence, effect upon the digestive system of the cow, effect upon the products, abundance of feed, balance of nutrients, the individuality of the animal, and economy.

PALATABILITY

Palatability is one of the most important points to consider in formulating a ration for dairy cows. If the feed is not palatable the cow will not eat as

much as she really requires and consequently will lose weight or decrease in milk flow, while unpalatable feeds will often throw cows off feed.

Feeds vary greatly in their palatability and there are also considerable variations in the palatability of different samples of any one feed. Likewise, cows vary in their likes and dislikes regarding feeds and individual cows may also vary in their tastes from time to time.

It is not possible to rank feeds absolutely according to their palatability but it may be said that as a rule the succulent feeds and the leguminous hays are among the most palatable concentrates, the by-products used as concentrates being in some cases not very palatable. There are an exceedingly large number of exceptions to this, however; for example, green sweet clover is usually unpalatable to animals at first tho it is both a succulent and leguminous feed; rye, tho a cereal grain, is not very palatable, while wheat bran, one of the by-products used as a concentrate, is very palatable.

Some feeds are at first unpalatable to animals but when they have been fed for some time the animals begin to like them; gluten feed and cottonseed meal, while as a rule not very palatable to cows when first fed, are relished later on. Many feeds that are unpalatable can be advantageously disposed of by feeding in mixtures, for example, malt sprouts and distillers' dried grains. Care should be taken, however, not to include too large a quantity of the unpalatable feeds in the mixed ration.

Certain preparations of feeds are more palatable than others; thus it is usually considered that cracked corn and ground oats are more palatable than the whole grains. This can not be laid down as an absolute rule, however, as a great deal depends on what the animals have been accustomed to.

The condition of a feed determines its palatability to a large extent. Badly weathered hay and moldy grain are quite unpalatable feeds and so great care must be taken to have all constituents of the ration in good condition if the best results are to be obtained from the feeding operations.

Cows will not clean up feeds that are unpalatable to them and as they very probably do not utilize unpalatable feeds to the fullest advantage, even when consumed, it can be seen that unpalatable feeds are unprofitable for two reasons. In some cases cows that are considered poor feeders and low producers can be rendered more productive by changing their feeds to make a palatable ration. This point emphasizes the necessity of individual feeding, especially where large records are aimed at. It shows that herd feeding may result not only in a waste of high priced feeds but also in a lowered milk production. Upon the feeder's ability to determine the most palatable ration for each of the animals, depends the size of the individual records of the cows.

VARIETY

The dairy cow, unlike the beef animal, is on feed for many successive long periods of time. As the best production can be obtained only by good feeding it is necessary that everything possible be done to keep the cow on feed. Palatability is an important factor in the feeding of milk cows and closely linked with it is variety in the ration. Variety does not mean a mixture of feeds from the same plant source such as corn fodder, corn meal, gluten feed, corn distillers' grains and so on, but refers to a mixture of feeds from distinct sources such as corn meal, wheat bran, ground oats, cottonseed meal, oil meal and so forth.

Frequent and radical changes in the ration are not to be recommended, as they tend to throw the cow off feed or cause digestive troubles. Rations composed of a limited number of constituents are apt to become unpalatable when fed for a long period and so rations composed of a fair number of different feeds are to be recommended. Even such rations, however, may at times become unpalatable and unsuited to the needs of the cow. The alteration of such a ration is an easy matter. The proportions of the various constituents present can be altered, one or more constituents left out, or new constituents added or used to replace constituents already present. In this way the ration can be kept in accord with the needs of the cow for main-

tenance and production and yet be palatable at all times. Slight changes in the constituents of a ration will usually do more towards increasing its palatability than will radical changes in the whole ration.

For good producing cows two roughages should be provided, preferably corn silage and a legume hay, and as a rule at least three or four constituents should be included in the grain mixture. In the corn belt, rations for dairy cattle too often consist of corn and corn-products with the addition of perhaps one roughage from another source. Such feeds are frequently cheap when bought by the ton but they do not form an economical dairy ration.

Variety in the ration with occasional slight changes in the constituents of the concentrate allowance will very frequently be all that is needed to keep the ration palatable and the cow doing her best work. In other cases, especially with high producers, it will be found advantageous to replace the grain ration with a bran mash occasionally. Such a mash is composed largely of wheat bran, but contains some oil meal and salt and is fed as a slop. This gives variety, stimulates the appetite and has a good effect on the digestive system and is to be recommended when cows become sluggish in their feeding.

It has lately been found that the value of a feed depends not entirely on its content of digestible protein and other nutrients but also on the presence of certain substances which are but little understood, and are deficient in some feeds. By giving a variety of feeds the presence of these essential constituents, or "vitamines", is practically assured. It has also been found that all proteins are not of like value in feeding and that sometimes a mixture of two proteins is more efficient than either of the two alone. This is another argument in favor of variety in the ration.

BULK

Unlike the hog, the cow has a large, roomy digestive tract, specially adapted to the handling of bulky feeds. A cow can handle a bulky feed much more efficiently than she can one that is not so bulky. There are two main reasons for this. Bulky feeds are easily regurgitated and so are more thorolv masticated and better prepared for further digestion than are more concentrated feeds. In the digestive tract of the cow heavy or concentrated feeds tend to form compact masses which resist the action of the digestive fluids and so do not yield all the nutrients which they are capable of providing, and in some cases they may even cause serious digestive disturbances.

Where there is plenty of bulky feed in the ration the best digestive action is obtained, as the hay and other bulky materials keep the particles of grain and other concentrated feed apart, and allow of their being thoroly acted upon by the digestive juices.

As the cow is preeminently a handler of roughages it is usually most economical to allow her to consume as much as possible of the rough feeds grown on the farm. Practical experience has shown that the best results will be obtained when the roughages, silage and hays as a rule, provide about two-thirds of the dry matter of the ration and the concentrates about one-third.

In the cases where a heavy grain ration is being fed, and even frequently where the grain allowance is not so large, it pays to have some bulky feeds in the concentrate part of the ration as well as amongst the roughages. This can usually be supplied by such feeds as corn-and-cob meal, wheat bran, ground oats and distillers' dried grains in this section. The particles of cob present in corn-and-cob meal have little, if any, nutritive value but their mere physical presence keeps the particles of corn apart, thus providing for the more thoro digestion and utilization of the corn. The action of the cob is almost entirely mechanical, but it is of such a nature that it renders corn-and-cob meal of about equal value to corn meal for feeding dairy cattle, when other bulky constituents are lacking in the grain ration.

The relative bulk of concentrates is well indicated by their weight per quart or per bushel, the lower the weight per quart, the more "bulky" is

the feed. Table III indicates the relative bulkiness of some of the more common grains and by-products.

TABLE III. APPROXIMATE WEIGHT PER QUART OF SOME COMMON FEEDS*

FEEDING STUFFS	Weight Per Qt. Lbs.	FEEDING STUFFS	Weight Per Qt. Lbs.
Shelled corn	1.7	Barley	1.5
Cornmeal	1.5	Malt sprouts	.6
Corn and cob meal	1.4	Brewers' dried grains	.6
Hominy feed	1.1	Buckwheat	1.4
Gluten feed	1.3	Cottonseed meal	1.5
Gluten meal	1.7	Linseed oil meal, O. P.	1.1
Germ oil meal	1.4	Linseed oil meal, N. P.	.9
Corn bran	.5	Beans	1.7
Wheat	1.9	Cowpeas	1.7
Wheat shorts	.8	Field peas	2.1
Wheat bran	.5	Soybeans	.8
Rye	1.7	Dry beet pulp	.6
Oats, whole	1.0	Distillers' dried grains	.6
Oats, ground	.7	Cane molasses	3.0

*From the extensive tables in "Feeds and Feeding," 17th Edition, by Henry & Morrison.

SUCCULENCE

A succulent ration has many beneficial effects. It supplies part of the large amount of water required by milking cows, increase the palatability of the ration, and has a laxative and cooling effect on the cow's digestive system. In the early part of the summer the pasture grass provides the necessary succulence but in the later part of the season it should be supplemented with corn silage or soiling crops; in winter silage is the most economical succulence in Iowa, tho it can sometimes be advantageously supplemented with beet pulp or roots.

EFFECT UPON DIGESTIVE SYSTEM

To work properly every cow should at all times be in perfect health and consequently the feeds selected should be such as will keep the digestive tract of the cow in its best working condition and maintain the cow in good health. The cow will do her best work when her ration is laxative in character .

Succulent feeds as already mentioned, have a beneficial effect on the digestive system and they also tend to keep the cow in good general health, so care should be taken to have abundance of succulence in the ration. Alfalfa and clover hays are also slightly laxative in effect and for this, among other reasons, are to be preferred to such feeds as timothy hay, oat straw, and corn stover, which are constipating.

Feeds that are moldy or in other ways spoiled are liable to cause digestive troubles and in addition may cause derangement of health or even be absolutely toxic and so should be avoided.

Many feeds have specific effects on the digestive and general health of the cows and so in compounding a ration for dairy animals it is necessary not only to have an abundance of succulence in the ration but also to see that the bad effects of any of the individual constituents of the grain ration are counterbalanced by the effects of other feeds. The specific effects of only a few feeds are definitely known and understood but it is very probable that many other feeds have specific effects on the general health of the animals. Cottonseed meal has a constipating effect and when fed in too large quantities may even be toxic in nature. Feeds such as wheat bran and oil meal have a laxative and cooling effect and should as a rule be fed when constipating feeds are included in the ration. Care should always be taken in compounding a ration to see that the bad effects that might be produced on the digestion or health of the cows by any of the feeds present are counteracted by other feeds.

EFFECT UPON PRODUCTS

Milk and butterfat are the marketable products of the dairy farm and so care must be taken to have no deleterious effects produced on those commodities by the feed given to the cows. As a rule the feed has no influence on the flavor of the milk provided the feeding is carefully done. Feeds such as rutabagas, which may cause a bad flavor in milk, should be given after milking and not before, and any feed not cleaned up in a short time removed.

Certain feeds influence to a limited extent the chemical and physical characteristics and consequently the consistency of butter. Linseed oil meal, peanut meal, and gluten products have a tendency to produce a soft, salvy butter with inferior flavor, while cottonseed tends to provide a hard, tallowy butter. These feeds do not produce marked effects unless fed in too large quantities, and by properly balancing the constituents of the ration these influences can be minimized. The feeding of cottonseed meal in the summer time is often advisable, as the butter produced at this season is generally soft and cottonseed tends to make it more firm.

ABUNDANCE OF FEED

The ultimate source of the various constituents of the milk is the feed and if copious milk production is to be expected liberal feeding must be practiced. A good producing cow may give large yields of milk for a time when poorly fed but to do this she must draw on her own body for the nutrients necessary for the process. The stores of nutrients in the cow's body are not inexhaustible and when they reach a certain degree of exhaustion the milk production must be decreased.

The greater the amount of feed a cow uses for milk production the less will be the relative importance of her maintenance requirements when considered as a part of her whole ration. Consequently, the more feed above maintenance requirements that a cow can be induced to consume and convert into milk and butterfat, the greater and more economical will be her production. Liberal feeding, when wisely practiced, gives the most profitable returns.

BALANCE OF NUTRIENTS

For the best production a cow must be supplied with sufficient digestible food nutrients—proteins, carbohydrates, fats and ash. This means that not only should the requisite amounts of total digestible nutrients be supplied but also that proper relations should exist between the various groups of digestible nutrients present and between the digestible and indigestible portions of the ration.

It has been found that to a considerable extent the main classes of nutrients—proteins, carbohydrates and fats—can be used interchangeably in the animal organism. For example, proteins can be used for the building up of body fat and the functions of the fat of the ration can be almost completely taken over by the carbohydrates. In spite of this, however, no one nutrient or group of nutrients, should be used to the exclusion of any other if the best results are desired.

Proteins are absolutely essential for the repair of the body tissues and the formation of the nitrogenous constituents of the foetus and the milk, while the majority of the other duties performed by proteins can be taken over by the carbohydrates and fats. It does not pay, however, to feed just the minimum amount of protein required for these vital processes as additional protein appears to have a stimulating effect on general metabolism and consequently on milk production. On the other hand again, proteins are as a rule higher priced than are the other nutrients and so too much protein in the ration will render milk production uneconomical. It is evident, therefore, that a balance must be preserved between the nitrogenous and non-nitrogenous constituents of the ration and the exact balance to be

used must be determined by the requirements of the individual animal and the relative costs of the various nutrients.

Similarly, carbohydrates and fats can be used interchangeably for certain purposes, and yet a proper balance from the nutritional and economic standpoint, should be maintained between these two classes of nutrients.

In balancing a ration attention must be given to the ash requirements of the animal. The information available on this subject is very scant but by having a variety of feeds and including a legume hay in the roughage there is seldom any danger of having an ash deficiency.

The problem of the balance of nutrients required by the dairy cow has received much attention and many feeding standards have been prepared to aid in its solution. In this publication an adaptation of the Modified Wolff-Lehmann Standard is used, as it is simple and easily applied to practical conditions, tho it must be remembered that a feeding standard is simply a guide to feeding methods rather than an absolute statement as to what ration a cow should receive.

TABLE IV. NUTRIENTS REQUIRED FOR PRODUCTION OF ONE POUND OF MILK (MODIFIED WOLFF-LEHMANN STANDARD)*

Percentage of Fat in Milk	Digestible Nutrients		Percentage of Fat in Milk	Digestible Nutrients	
	Crude Protein	Carbohydrate Equivalent		Crude Protein	Carbohydrate Equivalent
	pounds	pounds		pounds	pounds
2.5	.049	.207	5.0	.067	.335
3.0	.052	.234	5.5	.071	.357
3.5	.055	.261	6.0	.074	.380
4.0	.060	.286	6.5	.079	.403
4.5	.063	.313	7.0	.082	.423

*Adapted from the extensive tables in "Feeds and Feedings," 17th Edition, by Henry and Morrison.

The dairy cow requires feed for two main purposes—to support life and to produce milk. The nutrients needed for keeping the animal at a uniform weight and performing the essential functions of the body are known as the maintenance requirements, while those needed for milk production are called the production requirements.

According to the modified Wolff-Lehmann Standard the maintenance requirements of an animal are proportional to its live weight and a 1000 pound animal needs .7 lbs. of digestive crude protein and 7.225 lbs. of digestive carbohydrate equivalent daily for its maintenance.

The amount of nutrients required for production depends on the amount of milk produced and the percentage of fat it contains. In Table IV are given the requirements for the production of 1 lb. of milk of various grades and from this can be obtained the requirements for any stated yield of milk of known fat percentage.

As a sample of a ration made up according to this standard, take the case of a 1200 pound Holstein cow giving 40 lbs. of 3 pct. milk per day. The dairy requirements of this animal will be:

	Digestible Crude Protein	Digestible Carbohydrate Equivalent
	lbs.	lbs.
For maintenance	.84	8.67
For production	2.08	9.36
Total	2.92	18.03

The maintenance requirements were obtained by proportion from the maintenance requirements for a 1000 pound cow while the production requirements were obtained by taking 40 times the amount of nutrients required for the production of 1 lb. of 3 pct. milk.

Now that the requirements of the cow have been found to be 2.92 lbs. of digestible crude protein and 18.03 lbs. digestible carbohydrate equivalent, a ration must be found which will fulfil these requirements and at the same time be practical. The nutrients available in the various feeds can be found in Table V.

For the roughage part of the ration a reasonable allowance would be 36 lbs. of corn silage and 12 lbs. of alfalfa hay. These feeds will provide the following nutrients:

	Digestible Crude Protein lbs.	Digestible Carbohydrate Equivalent lbs.
36 lbs. corn silage	.40	5.98
12 lbs. alfalfa hay	1.27	4.92
	1.67	10.90

This leaves 1.25 lbs. of digestible crude protein and 7.13 lbs. of digestible carbohydrate equivalent to be furnished by the grain ration. A grain mixture can be found, by trial, which will supply this deficiency, for instance:

	Digestible Crude Protein lbs.	Digestive Carbohydrate Equivalent lbs.
4 lbs. corn and cob meal	.24	2.88
2 lbs. wheat bran	.25	.97
3 lbs. ground oats	.28	1.82
2 lbs. linseed oil meal O. P.	.60	.95
	1.37	6.62

This ration does not exactly coincide with the requirements of the standard but it is as close to it as it is necessary to calculate for practical purposes.

INDIVIDUALITY OF THE ANIMAL

The individual cow is the unit in profitable dairying and no matter how well rations are selected and balanced the work of the feeder can not give its best returns unless he caters to the animals as individuals. The cow is the best judge of the suitability of her ration and it is only by feeding in accordance with the tastes of the animal, her condition, and milk production that the best results can be obtained from the feed consumed.

ECONOMY

The main aim of the dairyman is usually profit, so considerable attention must be paid to economy of production. In general work there is little object in feeding a cow if she does not leave a profit. The factor of feed is the largest item in the cost of milk production and so is especially worthy of notice. In the feeding of a herd kept for economical milk production intensive feeding should be carried just to the limits of economy and no further. If it is carried beyond this limit the total yield of milk may be increased but the net profit will diminish.

In feeding, the aim should be to use as much home grown feed as possible, as the dairy cow must be considered the market for the feeds produced on the farm. If the difference in the cost between home grown and purchased feeds is not great, use the home grown feeds. In the consideration of the prices of feeds account should always be taken of the cost of marketing home grown products and that of buying other feeds on the market and bringing them to the farm. When comparing the prices of feeds use the local prices and do not buy feeds absolutely on the weight basis, buy on the basis of the nutrients supplied. No concentrate is absolutely indispensible—other products can always be obtained which will take the place of any one feed.

In the corn belt it should not be necessary to purchase much feed other than nitrogenous concentrates as the corn crop can produce a large amount of the roughage, chiefly in the form of silage, and most of the carbonaceous concentrates needed in the feeding of cows, while the remainder of the roughage can be provided by some legume hay.

TABLE V. NUTRIENTS IN 100 POUNDS OF SOME COMMON FEEDS

FEED	Total Dry Matter	Crude Protein	Carbohydrate	Fat	Carbohydrate Equiv'l't	Total Ash
CONCENTRATES						
Corn, whole	80.5	7.5	67.8	4.6	78.2	1.5
Corn, soft	69.4	5.5	53.3	3.5	61.2	1.0
Cornmeal	88.7	6.9	69.0	3.5	76.9	1.3
Corn and cob meal	80.6	6.1	63.7	3.7	72.0	1.5
Hominy feed	89.9	7.0	61.2	7.3	77.6	2.6
Gluten meal	90.9	30.2	43.9	4.4	53.8	1.1
Gluten feed	91.3	21.6	51.9	3.2	59.1	2.1
Germ oil meal	91.1	16.5	42.6	10.4	68.0	2.7
Corn bran	90.0	5.8	50.9	4.6	66.3	2.4
Distillers' Dried grains, corn	93.4	22.4	40.4	11.6	63.5	2.6
Wheat	89.8	9.2	67.5	1.5	70.9	1.9
Red dog flour	88.9	14.8	56.5	3.5	64.4	2.5
Wheat shorts	89.6	13.4	46.2	4.3	55.9	4.4
Wheat bran	89.9	12.5	41.6	3.0	48.4	6.3
Rye	90.6	9.9	68.4	1.2	71.1	2.0
Ground oats	89.2	9.4	51.4	4.1	60.6	3.8
Barley	90.7	9.0	66.8	1.6	70.4	2.7
Brewers' dried grains	92.5	21.5	30.5	6.1	44.2	3.5
Buckwheat	87.0	8.1	49.7	2.5	55.3	2.1
Emmer (Spelt)	91.3	9.5	63.2	1.7	67.0	3.7
Cottonseed meal	92.5	37.0	21.8	8.6	41.2	6.2
Cold-pressed cottonseed cake	92.1	21.1	33.2	7.4	49.8	4.2
Linseed oil meal, O. P.	90.9	30.2	32.6	6.7	47.7	5.4
Linseed oil meal, N. P.	90.4	31.7	37.9	2.8	44.2	5.6
Cowpea	88.4	19.4	54.5	1.1	57.0	3.4
Field pea	90.8	19.0	55.8	.6	57.2	3.4
Soybean	90.1	30.7	22.8	14.4	55.2	5.3
Cane molasses	74.2	1.0	58.2	----------	58.2	6.4
DRY ROUGHAGES						
Corn fodder	81.7	3.0	47.3	1.5	50.7	5.0
Corn stover	81.0	2.1	42.4	.7	44.0	5.5
Oat straw	88.5	1.0	42.6	.9	44.6	5.4
Rye straw	92.9	.7	39.6	.4	40.5	7.1
Wheat straw	91.6	.7	35.1	.5	36.2	3.4
Millet hay	85.7	5.0	40.0	1.8	50.0	6.3
Mixed grass hay	87.2	4.3	44.3	1.2	47.3	5.6
Prairie hay	93.5	4.0	41.4	1.1	43.9	7.7
Timothy hay	88.4	3.0	42.8	1.2	45.5	4.9
Sudan grass hay	91.6	3.3	53.4	.9	55.4	5.8
Oat hay	88.0	4.5	38.1	1.7	41.9	6.8
Clover and timothy hay	87.8	4.0	39.7	1.1	42.2	6.1
Oat and pea hay	83.4	8.3	37.1	1.5	36.5	7.3
Alfalfa hay	91.4	10.6	39.0	.9	41.0	8.6
Red clover hay	87.1	7.6	39.3	1.8	43.2	7.1
Sweet clover hay	91.4	10.9	38.2	.7	39.8	7.2
Cowpea hay	90.3	13.1	33.7	1.0	35.9	11.9
Soybean hay	91.4	11.7	39.2	1.2	41.9	8.6
Dry beet pulp	91.8	4.6	65.2	.8	67.0	3.5
SUCCULENT FEEDS						
Bluegrass	31.6	2.3	14.8	.6	16.2	2.8
Timothy	37.5	1.5	19.3	.8	20.7	2.2
Sudan grass	25.9	.8	14.7	.3	15.5	1.8
Corn fodder	21.9	1.0	12.8	.4	13.7	1.2
Corn stover	22.7	.5	12.0	.2	12.4	1.4
Alfalfa	25.3	3.3	10.4	.4	11.3	2.4
Red clover	26.2	2.7	13.0	.6	14.4	2.1
Sweet clover	24.4	3.3	10.3	.3	11.0	2.1
Cowpea	16.3	2.3	8.0	.3	8.7	2.0
Field pea	16.6	2.9	7.1	.3	7.8	1.6
Soybean	23.6	3.2	10.2	.5	11.3	2.4
Oats and peas	22.6	2.4	10.6	.6	12.0	2.0
Sugar beets	16.4	1.2	12.6	.1	12.8	1.1
Mangels	9.4	.8	6.4	.1	6.6	1.0
Rutabagas	10.9	1.0	7.7	.3	8.4	1.0
Turnips	9.5	1.0	6.0	.2	6.4	.9
Corn silage from mature corn	26.3	1.1	15.0	.7	16.8	1.7
Immature corn	21.0	1.0	11.4	.4	12.3	1.4
Frosted corn	25.3	1.2	13.7	.6	15.1	1.8
Field cured stover	19.6	.5	9.9	.4	10.8	1.4

Adapted from the extension tables in "Feeds and Feeding," 17th Edition, by Henry & Morrison.

The main point to which attention must be paid in the purchase of nitrogenous concentrates is the cost of the digestible crude protein present, as this is the constituent for which these concentrates are purchased.

The digestible carbohydrate equivalent in the various concentrates is practically of a uniform feeding value, pound for pound, no matter what is the source of the feed, so in calculating the cost of the digestible protein a uniform, tho arbitrary, value of one cent per pound is placed on the digestible carbohydrate equivalent.

From the cost of 100 pounds of feed is subtracted the value of the digestible carbohydrate equivalent present and the difference, when divided by the percentage of digestible crude protein and multiplied by 100, gives the cost of 100 lbs. of digestible crude protein in the given feed at the price stated.

For example, which is the cheaper source of protein, wheat bran at $38.00 per ton or old process oil meal at $70.00 per ton, if the bran contains 12.5 pct. digestible crude protein and 48.4 pct. digestible carbohydrate equivalent, and the oil meal 30.2 pct. digestible crude protein and 47.7 pct. digestible carbohydrate equivalent?

Wheat Bran

Cost per ton, $38.00; cost per 100 lbs	$ 1.90
Cost of carbohydrate equivalent at 1c per lb	.48
Cost of 12.5 lbs. digestible crude protein	1.42
Cost of 100 lbs. digestible crude protein	11.33

Oil Meal

Cost per ton, $70.00; cost per 100 lbs	$ 3.50
Cost of carbohydrate equivalent at 1c per lb	.48
Cost of 30.2 lbs. digestible crude protein	3.02
Cost of 100 lbs. digestible crude protein	10.00

The oil meal is evidently the cheaper source of digestible protein at the prices given. In table VI is given the cost per 100 pounds of digestible crude protein in some common feeds at a wide range of prices.

In using a table such as this, two important facts have to be kept in mind; first, some feeds are not bought as a source of cheap protein; second, all nitrogenous feeds do not suit under the same conditions. Feeds such as corn-and-cob meal or hominy feed are used as sources of energy and not of protein in a ration and so can not be bought on the basis of protein content alone. The feeding of cottonseed meal would not be advisable in all cases where bran can be used; for example, cottonseed meal is a good concentrate to use where plenty of succulence is available but it is not very useful when succulent feeds are absent, or in the feeding of pregnant cows, while bran is eminently successful under those very conditions. With these limitations such a table is a satisfactory guide in the selection of nitrogenous concentrates to supplement the roughages and carbonaceous grains produced on the farm.

FEEDING DAIRY ANIMALS

THE CALF

For the best success in dairying the herd should be built up from animals reared on the farm. In this way heifers from ancestry of known productive capacity are obtained and every care can be given to their development. Calf rearing has been given more detailed treatment in Circular 50 of the Iowa Agricultural Experiment Station, but brief attention will be given here to the feeding of the young calf.

There is some difference of opinion as to whether or not the new born calf should be allowed to remain with its dam. It is probably best, however, to leave it with its dam for two or three days. This allows the calf to obtain the first milk or colostrum which is so necesary for its well being. The colostrum has a laxative action and aids in getting the digestive tract into good working order. The colostrum can be milked and fed to the calf, but the calf will do better if it is with the dam as it is then able to get the milk warm and at short intervals. The sucking of the calf also aids in relieving any inflammatory condition there may be in the cow's udder at this time.

TABLE VI. COST PER 100 POUNDS OF DIGESTIBLE CRUDE PROTEIN IN CONCENTRATES AT VARIOUS PRICES

COST PER TON	$30	$32	$34	$36	$38	$40	$42	$44	$46	$48	$50	$52	$54	$56	$58	$60	$62	$64	$66	$68	$70
FEEDS	Cost per 100 Pounds Digestible Crude Protein in Dollars and Cents																				
Corn, whole	9.57	10.21	12.24	13.57	14.91	16.24	17.57	18.91	20.21	21.57	22.91	24.24	25.57	26.91	28.24	29.57	30.91	32.24	33.57	34.91	36.24
Cornmeal	10.59	12.04	13.49	14.94	16.39	17.84	19.29	20.74	22.19	23.64	25.09	26.54	27.99	29.43	30.88	32.33	33.78	35.23	36.68	38.13	39.58
Corn and cob meal	12.79	14.43	16.07	17.70	19.34	20.98	22.29	24.26	25.90	27.54	29.18	30.83	32.46	34.10	35.74	37.38	39.02	40.66	42.20	43.84	45.57
Hominy feed	10.34	11.77	13.20	14.63	16.06	17.49	18.91	20.34	21.77	23.20	24.63	26.06	27.48	28.91	30.34	31.77	33.20	34.63	36.06	37.49	38.91
Gluten feed	4.31	4.67	5.13	5.60	6.03	6.52	6.99	7.45	7.91	8.38	8.84	9.30	9.72	10.23	10.69	11.15	11.61	12.08	12.54	3.00	13.47
Gluten meal	3.19	3.52	3.85	4.18	4.51	4.84	5.17	5.50	5.83	6.17	6.50	6.83	7.16	7.49	7.82	8.15	8.48	8.81	9.15	9.48	9.81
Germ oil meal	5.09	5.70	6.30	6.91	7.52	8.12	8.73	9.33	9.94	10.55	11.15	11.76	12.36	12.97	13.58	14.18	14.79	15.39	16.00	0.61	17.21
Red dog flour	5.78	6.46	7.14	7.81	8.49	9.16	9.84	10.51	11.19	11.86	12.54	13.22	13.89	14.57	15.24	15.92	16.59	17.27	17.95	1.62	19.30
Wheat shorts	7.02	7.77	8.51	9.26	10.01	10.75	11.50	12.25	12.99	13.74	14.49	15.23	15.98	16.72	17.47	18.22	18.96	19.71	20.46	21.20	21.95
Wheat bran	8.13	8.93	9.73	10.53	11.33	12.13	12.93	13.73	14.53	15.33	16.13	16.93	17.73	18.53	19.33	20.13	20.93	21.73	22.53	23.33	24.13
Oats, whole	9.21	10.24	11.27	12.30	13.33	14.36	15.39	16.42	17.46	18.48	19.52	20.55	21.58	22.61	23.64	24.67	25.70	26.73	27.76	28.79	29.82
Oats, ground	9.51	10.57	11.64	12.70	13.77	14.83	15.89	16.96	18.02	19.09	20.15	21.21	22.28	23.34	24.40	25.47	26.53	27.60	28.66	29.72	30.79
Barley	8.84	9.96	11.07	12.18	13.29	14.40	15.51	16.62	17.73	18.84	19.90	21.07	22.18	23.29	24.40	25.51	26.62	27.73	28.84	29.96	31.07
Malt sprouts	4.91	5.40	5.90	6.39	6.88	7.37	7.87	8.36	8.85	9.34	9.84	10.33	10.82	11.32	11.81	12.30	12.79	13.29	13.78	14.27	14.76
Brewers' dried grains	4.92	5.39	5.85	6.32	6.78	7.25	7.71	8.18	8.64	9.11	9.58	10.04	10.50	10.97	11.43	11.90	12.36	12.83	13.29	13.76	14.22
Cottonseed meal	2.94	3.21	3.48	3.75	4.02	4.29	4.56	4.83	5.10	5.37	5.64	5.91	6.18	6.45	6.72	6.99	7.26	7.53	7.80	8.07	8.34
Cold-pressed cottonseed cake	4.75	5.22	5.70	6.17	6.64	7.12	7.59	8.07	8.54	9.01	9.49	9.96	10.44	10.91	11.38	11.86	12.33	12.81	13.28	13.75	14.23
Linseed oil meal (O. P.)	3.39	3.72	4.05	4.38	4.71	5.04	5.37	5.71	6.04	6.37	6.70	7.03	7.36	7.69	8.02	8.35	8.69	9.02	9.35	9.68	10.01
Cowpea	4.79	5.31	5.82	6.34	6.86	7.37	7.89	8.40	8.92	9.43	9.95	10.46	10.98	11.49	12.01	12.53	13.04	13.56	14.07	14.59	15.10
Field pea	4.88	5.41	5.94	6.46	6.99	7.52	8.04	8.57	9.09	9.62	10.15	10.67	11.20	11.73	12.25	12.78	13.31	13.83	14.36	14.88	15.41
Soybean	3.09	3.41	3.74	4.07	4.39	4.72	5.04	5.37	5.69	6.02	6.35	6.67	7.00	7.32	7.65	7.97	8.30	8.63	8.95	9.28	9.60
Distillers' dried grains (corn)	3.73	4.17	4.62	5.07	5.51	5.96	6.41	6.85	7.30	7.75	8.19	8.64	9.08	9.53	9.98	10.42	10.87	11.32	11.76	12.21	12.66
Distillers' dried grains (rye)	7.15	7.88	8.62	9.35	10.09	10.82	11.53	12.29	13.03	13.76	14.50	15.24	15.96	16.71	17.44	18.18	18.91	19.65	20.38	21.12	21.85

When the calf is two or three days old it can be taken away from the dam and fed fresh, warm, whole milk in a clean bucket at the rate of 2 to 4 pounds three times a day, depending on the size and vigor of the calf. When the calf is about three weeks old the feeding can be done twice a day and the substitution of skimmed milk for whole milk can be started. This substitution should take place slowly until the calf is about six weeks old when it should be getting an allowance of 13 to 16 pounds of warm skimmed milk per day. The allowance of milk should not be increased too rapidly as over feeding will cause digestive troubles. Similarly the milk should be fed in clean buckets and as soon after milking as possible so that it will still be warm. When on full feed, 16 to 18 pounds of milk will be found about sufficient for a calf. The skimmilk feeding should be continued till the calf is seven or eight months old.

Calves will begin taking a little grain even when but a few weeks old and an excellent grain mixture for them is one of equal parts of corn, bran, and oats with small quantities of oil meal. Cracked corn should be fed at first and later shelled corn may be substituted. There is some difference of opinion as to whether whole or ground oats should be used.

Alfalfa hay should not be fed alone to young calves as it is too rich for them and is likely to cause kidney and digestive troubles. Clover hay, or a mixture of clover and alfalfa, is better than alfalfa alone.

Calves that are dropped in the fall and winter should be allowed good pasture the following summer and if provided with shade and a little grain will do well. Those that are dropped in the late spring or summer will do better if properly cared for in the barn, at least until there is cool weather in the fall.

THE GROWING HEIFER

If fall calves have been properly treated during the winter it is not difficult to carry them thru the summer. They should be on pasture as much as possible and in addition receive a little grain. The ration can consist of the same constituents as were used earlier, but the corn and oats should be increased at the expense of the oil meal and bran. Ample shade is necessary. When cold weather comes a shed should be available for the heifers.

As the main object in feeding dairy heifers is to produce animals with plenty of constitution and capacity, let the feed be bulky and at the same time contain plenty of protein and ash. The protein and ash aid in the building of muscle and bone and bulky feeds distend and develop the digestive organs. Alfalfa and clover hays are excellent roughages to feed to dairy heifers and silage is useful in limited amounts. Where silage is available 15 to 20 pounds of it may be fed per day to dairy heifers during the winter and this, with 7 to 8 pounds of alfalfa or clover hay and 2 to 3 pounds of grain, makes a good ration. Where silage is not available the amount of hay can be doubled and another pound of grain fed.

Spring or summer calves are not so easily cared for during the winter as are calves of the previous fall, but should be fed very similarly, tho the amount of silage allowed should be limited. During the following summer the heifers will need little but pasture until fall, when the treatment may be similar to that of the previous season.

THE DRY COW

Every dairy cow, in order to give the best results, requires a rest of six weeks or two months between lactations. During this time she should be prepared for her year's work, her reserve stores of nutrients built up, and her digestive tract rested and cooled as much as possible. Of course, nourishment must also be supplied for the growing foetus.

If the cow is dry during the summer or early fall she will need very little extra care if she is on good pasture. A pasture separate from the general herd is advisable as there is then less danger of injury. During this period no more grain than is necessary should be fed as it allows the digestive system of the cow to rest, but a few pounds of oats and a little bran will

often be found advisable. If the cow is in poor condition a little corn may be added, but it is not advisable to give much of such heating feeds. If it is necessary to flesh up the cow this should be done gradually.

When the dry period occurs in winter the ration should consist of 20 to 25 pounds of corn silage with a liberal allowance of legume hay and a grain ration consisting of a mixture of 3 parts ground oats, 2 parts wheat bran and 1 part oil meal; the amount of the grain ration being governed by individual requirements.

During this period the ration should be laxative in nature and should contain little of such heating feeds as corn, except when the cow is in poor condition, and feeds such as cottonseed meal and timothy hay should be avoided.

THE COW IMMEDIATELY BEFORE PARTURITION

A few days before freshening, the grain ration should be considerably reduced and at this time a mixture of 2 parts bran and 1 part oil meal is excellent as it keeps the bowels laxative. If this mixture does not give the desired effect a dose of one quart of raw linseed oil or 1 pound of Epsom salts should be given. Freedom from milk fever and other post-parturient troubles is in a large measure due to the care with which the cow is handled and fed just previous to freshening.

THE COW IMMEDIATELY AFTER PARTURITION

For a day or two after calving feed the cow bran mashes in addition to alfalfa or clover hay and a limited amount of silage. During this period warm the drinking water slightly. A mixture of bran, ground oats and oil meal may be used to replace the bran in a day or two.

It is a recognized fact that thirty days is required to put a beef steer on to full feed and at least this length of time should be given to the bringing of the dairy cow to a full ration. This is easily seen when it is remembered that the dairy cow is not only on feed much longer than is the beef animal, but she does the same work for several years. In addition, parturition has a distinctly weakening effect on the system and the digestive functions suffer along with the others. Consequently, great care should be exercised in raising the cow's ration to the profitable maximum as a too rapid raise in feed will result in indigestion, bloat or other digestive trouble.

Beginning with 4 or 5 pounds of grain per day on the fourth or fifth day after freshening, the grain should be increased at the rate of 1 pound per day on every third or fourth day until the cow's maximum production of milk is reached. When this is reached, that is when the milk yield does not increase in response to an increase in grain, the grain ration should be slightly reduced and it will, as a rule, be noted that the cow will again increase a little in milk production. In other words, the cow does her best work when her digestive system is not overloaded. The amount of grain then being fed is about what she should receive as any less will not give the best production and additional feed would be used for the production of body fat and consequently would be wasted so far as milk production is concerned.

THE MILKING COW

In feeding cows for milk production the main point to keep in mind is the individual cow. Each cow has her own requirements for maintenance and production and in addition attention must be paid to her likes and dislikes if the best results are to be obtained.

A cow should receive an abundance of feed, containing plenty of nutrients in the right proportions and made up of feeding stuffs that she likes. Economy must also be considered and this is of special importance with the present high prices of concentrates. In the corn belt the chief concentrates that have to be purchased are nitrogenous ones and so in buying these determine the cost of protein, as already described.

Regulate the feed of the cow according to her production and her condition. Give enough feed to keep the cow producing to the best of her

ability and in fair condition and do not allow her to become poor or fat. When poor in condition the cow is evidently not getting enough feed and is drawing on her body for nutrients to keep up her yield of milk, while excessive fatness tends to decrease the productiveness of a cow.

The production of a cow should be determined by means of the milk scales and the Babcock tester and with their "advice" the feeding operations can be conducted intelligently. As a rule the grain ration will be determined by the production and the roughage ration by the live weight of the cow. One pound of grain can generally be fed for each 2½ to 4 pounds of milk produced, depending on the richness of the milk and the total amount produced. Jerseys and Guernseys require more grain per pound of milk than do Holsteins and Ayrshires. Another simple method of determining the grain requirements is to allow 7 pounds of grain for each pound of butterfat produced. High producing cows require for production purposes more grain and grain of a more nitrogenous character than do poor producers.

The live weight of a cow is a good index of whether she is being fed properly or not, but good judgment, or better yet, accurate scales must be used in regulating the ration according to this condition. The weight of a cow should not be expected to remain constant thruout the lactation period as under average conditions she will decrease in weight for the first 6 to 12 weeks after calving. This post-parturient decrease in weight will depend largely on the condition of the cow at the time of freshening and her inherent ability to produce. The greater this ability is, the greater will be her decrease in weight after parturition. After this initial loss the cow should remain about constant in weight for some time, depending largely on the time of her next calving. For a period of from 2 to 5 months previous to freshening, cows may be expected to increase in weight. Only a small portion of this increase is due to the growth of the foetus, the rest being due mainly to storage of body fat which should later be used for milk production.

Heifers during their first and second lactation periods require heavier feeding proportionately than do mature cows. The obvious reason for this is the growth of the animal. A cow with a beefy tendency is usually fed a narrower nutritive ratio than one which possesses the nervous temperament so much sought.

Tho liberal feeding is advisable, overfeeding must be strictly guarded against as overfeeding will cause a considerable amount of damage. When a cow has been overfed the grain ration must immediately be cut down, only such feeds as bran, oil meal, and ground oats being provided, and after a few days the grain may be increased gradually as the cow regains her appetite. It is also sometimes advisable to feed a bran mash in place of the grain ration.

In this latitude the maximum milk production is usually obtained during June, the flow reaching its greatest magnitude shortly after the cows are turned on pasture. This suggests that at this season the conditions are most favorable for milk production and that they should be imitated as far as possible thruout the remainder of the year. Stimulation of summer conditions thruout the year brings about the greatest and most economical milk production.

In changing the cows from winter feed to pasture it is better to proceed slowly especially in the case of heavy milking cows as the young immature grass of early spring contains a very small amount of dry matter and it is difficult for a heavy milking cow to eat enough of such feed to supply the nutrients she needs for maintenance and production. If the cows are put on the pasture too suddenly the flavor of the milk is also adversely affected, and the young grass tends to cause scouring.

When the milking herd is put on pasture the winter roughage will be cut down rather rapidly and the grain ration more slowly. The feeding of a little hay for a short time after the cows are turned on pasture helps to counteract the laxative action of the grass. As soon as the cows

have become thoroly accustomed to pasture all other feeds may be eliminated except in the case of the heaviest milkers and even they should not receive any more grain than is absolutely necessary.

The elimination of grain feeding for the first four to six weeks after the cows have been turned on pasture has everything to recommend it. The absence of concentrates from the ration at this time allows the digestive system of the cow to rest and she is in better condition to handle grain when feeding of it again becomes necessary.

Tho average producing cows do not need any additional feed in the early part of the grazing season the pastures on most Iowa farms do not furnish enough feed for the cattle during the hot dry months of summer. The problem of supplying this may be solved by one or more of the following practices: better care and management of pastures; use of large quantities of concentrates; use of summer silage; production of soiling crops.

As a general rule it is advisable to have some pasture for the cows tho good results can be obtained without it. The pasture should be kept producing to the best of its ability but even under the most favorable pasture conditions it will usually be found advantageous to provide silage or soilage for the milking herd during the dry season.

Pasture alone does not supply the necessary nutrients demanded by high producing cows which require some grain in order to continue producing to the best of their ability. Medium or mediocre producers will not yield much more milk when fed grain on pasture and the additional yield will not as a rule pay for the grain. It has been found that cows which are fed grain during the summer will produce better during the following winter than those which are fed no grain, consequently when the cows are above the average in production the best policy will usually be to feed grain during the latter part of the pasture season at least.

Feeds suitable for summer feeding are cracked corn, ground oats and cottonseed meal. They keep the cow up in production during the summer and aid in building up her body to withstand the strain of continued milk production during the succeeding winter. Cottonseed meal, having a constipating effect, also counteracts the laxative action of washy pasture. Where cows on pasture are receiving only a small amount of grain, corn is as good as any other concentrate, as with the pasture it provides a fairly well balanced ration—provided of course that it is as cheap as other grains—but where cows are getting large amounts of grain, 5 pounds per day or over, other feeds nitrogenous in character should be used.

Granting that the pastures are well tended, and the grain feeding is judiciously handled, the fact remains that these two factors are not sufficient to maintain economical milk production during the warm, dry months. In this period three factors contribute towards lessened production—a lack of succulent feed, warm weather, and flies—and of the three the first is much the more important. Many agree that the loss occurring at this time from lack of feed exceeds the loss occasioned by improper winter feeding. At this time when the cows are on pasture, and little else, and field work is pressing, the farmer often neglects the dairy cow. On the other hand, in winter the owner expects to feed his stock and is prepared for it.

Under average dairy conditions the cows freshen in the spring, give a good flow while the pasture lasts, but when hot weather and dry pasture come, the flow drops one-half to two-thirds, and the cows are almost dry at the beginning of winter. It is almost impossible to restore the flow of milk to the original amount after it has once been allowed to run down from lack of feed. To make large returns from the cows the yearly production must be had and to secure this it is essential to prevent the midsummer drop.

As indicated previously it is possible to maintain the milk flow by heavy grain feeding, but this is unnecessarily expensive. Provision therefore should be made to have green crops on hand that may be cut and fed as needed or to have silage available.

While silage or soilage are essential for economical summer milk production the choice between them will depend on individual conditions. It is

generally believed that silage will give the most economical and soiling the largest milk production. Details regarding the factors which will determine the choice between them are given in Bulletin 187 of the Iowa Agricultural Expermiment Station.

In winter feeding a bulky succulent ration that provides plenty of nutrients is desired. Where silage is available profitable winter feeding is easily possible, especially if a leguminous hay, alfalfa or clover, can also be obtained. A suitable daily allowance is 25 to 35 pounds of silage and 10 to 15 pounds of legume hay. These two constituents provide the necessary bulk while the silage renders the ration succulent and in addition they can usually be depended on as a cheap source of nutrients.

Where roots are available the same end can be gained but they are not generally available in this section in sufficient quantities to be of any great importance. Where silage and roots cannot be obtained, dried beet pulp when fed soaked, is a very valuable feed for providing the succulent part of the ration.

If succulent feeds and leguminous hays are not available the winter feeding of dairy cattle becomes much more difficult and the very best results can not be hoped for under such conditions.

The grains that should be used in winter feeding depend largely on the nature of the roughage ration and the market prices of concentrates. Where succulent feeds are used the demand for laxative feeds such as bran and oil meal is not so great as it is in the cases where the only roughages fed are dry. The concentrate allowance should at all times, and especially in winter, consist of a variety of constituents as this will give the most economical results. The actual amount of grain fed should be determined, as already shown, by the production of the cow.

With consistent methods of feeding, the milk production of dairy cows can be prevented from declining rapidly during the winter and the cows will be kept in such shape that not only will they give large yields when the price of milk is high, but they will also respond with increased production when turned to pasture in spring.

Owing to the large variations in feed prices in various localities and at different times, it is not possible to recommend grain mixtures which will always be economical, but the following sample mixtures are good under the conditions mentioned, providing that they can be bought at reasonable prices. When the prices of these feeds are too high, other feeds of similar character but lower price can be substituted.

The following mixtures make good grain rations when silage and a legume hay are fed:

Sample A.
400 lbs. cracked corn, corn-and-cob meal or hominy feed.
200 lbs. ground oats.
100 lbs. cottonseed meal.
100 lbs. linseed oil meal (O. P.)

Sample B.
400 lbs. cracked corn, corn-and-cob meal and hominy feed.
100 lbs. ground oats.
100 lbs. wheat bran.
100 lbs. cottonseed meal.
100 lbs. linseed oil meal (O. P.).

Sample C.
400 lbs. cracked corn, corn-and-cob meal or hominy feed.
200 lbs. ground oats.
100 lbs. gluten feed.
100 lbs. wheat bran.

The next mixture would be better than either of these in the absence of silage:

Sample D.
300 lbs. cracked corn, corn-and-cob meal or hominy feed.
100 lbs. ground oats.
100 lbs. gluten feed
100 lbs. wheat bran.
200 lbs. linseed oil meal (O. P.).

Such sample mixtures are only rough guides as to the concentrates to use, as much depends on local markets.

THE BULL

During the first six months of life the treatment of the young bulls is the same as for heifer calves, but at the end of this time they should be separated from the heifers, and begin to receive rather more grain.

With older bulls, where the main object is to keep them in good breeding condition, the ration should consist largely of alfalfa or clover hay and grain with a little silage. Good results can not be obtained by feeding large quantities of silage to the dairy bull as this causes over-distension of the middle and he is likely to become sluggish and slow in breeding. Not more than 10 to 15 pounds per day of silage should be fed. The grain ration should contain a good percentage of protein. Cracked corn, ground oats and bran with the addition of a little oil meal makes an excellent grain ration for the dairy bull.

SALT

Salt is essential to the dairy cow. There are three common methods of salting cows, viz., to have it before them all the time, to give them access to it at stated intervals, and to mix it with the feed.

The first of these three methods is much to be preferred and the last method is not to be advised as some cows will get more than they need and others not enough. The requirements of a cow depend on her live weight and her milk production. The salt in the feeds will also determine to a certain extent the amount of additional salt required by the cow. As a rule about 1 oz. daily is required by a milk producing dairy cow.

All young animals and bulls as well as dry cows likewise require salt but not in such large quantities.

WATER

Water, the main constituent of milk, is very essential for milk production. From work at the Iowa Agricultural Experiment Station it has been found that 3 to 5 pounds of water are required for each pound of milk produced. This is in addition to the water in the pasture grass, silage and other feeds.

Keep the water supply pure and fresh. Being protected from all contamination by surface water, deep well water is the best. In summer water should always be available to the cows when at pasture. This water should be kept in a tank, or, if it is in a stream, it should be so protected that the cows cannot stand in it and convert it into a puddle. Water should also be where the cows can obtain it on their way to and from the barn. In winter the cows should not be turned out into a windswept lot and allowed to drink ice-cold water. If it is necessary for the cows to drink outside in winter, furnish the tanks with heaters.

Water the cows in the barn if possible. Individual drinking cups have the advantage of keeping the water before the cow at all times, but they also have their drawbacks. Continuous cement mangers, fitted with a faucet at one end and a drain at the other, are less complicated and have many advantages. With these the cows can be very easiy watered two or three times a day and the water is always fresh. Whatever the method used, the cows should get all the water they want.

ORDER OF FEEDING

Much more important than the time or order of feeding is regularity. It does not do to feed a cow just when the feeder feels inclined; she should have regular meal hours. Many feed the grain before the roughages, as the cow eats her grain rapidly and then takes her time with the coarser feeds. A very good method is to put the grain on top of the silage. The grain is sometimes fed at milking time. Hays which are likely to cause dust in the barn, and feeds, such as silage and roots, which tend to impart taints to the milk, should be fed after milking and not before. A good method is to feed the hay two or three times a day and the silage and grain twice. This allows the cow to make better use of her feed than if it were fed less often in larger quantities. Grain, if fed only once in a large quantity, is also likely to cause digestive troubles.

METHOD OF FEEDING

The most convenient way of feeding silage is with a wagon which can be filled at the silo and then pushed round in front of the cows and the silage fed with a scoop. If a few scoopfuls of silage are weighed occasionally the silage can be fed with a fair degree of accuracy.

Baled hay is very convenient for feeding. If home grown hay is used place the hay chute so the feeding may be done with the least trouble. The allowance of hay, as of silage, should be weighed occasionally.

The mixtures and quantities of grain to be fed should be determined for each cow individually. Where this is not convenient a general mixture which is found to be economical can be made up and then weighed out for each cow.

There are four general methods of feeding the grain ration.

1. A cabinet of drawers, each large enough to hold one day's grain allowance for a cow, is provided. Each day the allowance for each cow is weighed and put in a drawer and at feeding time the cabinet is wheeled in front of the cows.
2. A row of covered boxes large enough to hold a week's feed is built in front of the cows and each week the grain is weighed and placed therein. At feeding time each cow's allowance is measured out with a scoop.
3. A feed wagon divided into compartments may be used. There is a separate feed in each compartment and at feeding time the allowances are weighed out on a spring balance scale which is attached to the wagon.
4. A mixture known to be economical can be made up and measured or weighed out to each cow daily.

When it is convenient to measure feeds rather than weigh them the table showing the relative bulk of the different feeds will be convenient as it gives their weights per quart.

With each of these methods there should be a simple feed sheet showing what each cow is to receive. In this way accurate feeding will be done and the maximum and most economical production of milk will be obtained.

PRODUCTION POINTERS

BREED

1. High producing cows are the basis of profitable dairying; the most economical results can not be obtained with poor producers.
2. A good sire will rapidly grade up a herd to high production; any pure bred sire will not do—he must be able to transmit producing ability to his offspring.

FEED

3. The care given to dairy heifers will determine to a great extent the profits they will make when they join the milking herd.
4. A good cow will respond to good treatment and even a poor cow will increase in production if she is properly handled.
5. Without liberal feeding liberal returns can not be obtained. A heavy producing cow can not do her best work unless she is well fed.

WEED

6. The milk scales and the Babcock tester are the impartial judges of a cow's producing ability.